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A NEW SPECIES OF SUBTERRANEAN ISOPOD CRUSTACEAN (ASELLIDAE) FROM THE CENTRAL APPALACHIANS, WITH REMARKS ON THE DISTRIBUTION OF OTHER ISOPODS OF THE REGION

By John R. Holsinger and Harrison R. Steeves, III
Department of Biology, Old Dominion University, Norfolk, Virginia 23508 and
Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

For the past 10 years extensive collecting in the caves of the central Appalachians, principally in western Virginia and eastern West Virginia, has accelerated the accumulation of new data on the subterranean fauna of this significant karst area. Additional collecting has also been carried out in the caves of adjacent Maryland and Pennsylvania, both by the senior author and other speleologists. One of the most common cave forms of this area are isopods of the genus *Asellus* s. lat., representatives of which occur in almost every suitable cave habitat in the four-state area.

The rich subterranean isopod fauna of the central Appalachian cave region has been treated previously by Levi (1949), Bresson (1955), Chappuis (1957), Steeves (1963a, 1963b, 1965, 1966, 1969), and Bowman (1967). Despite this proliferation of published information on the group in recent years, field investigations have continued to result in the discovery of new species and the acquisition of new localities and range extensions for previously known species. Some of these new data, along with the description of one of the new species, are reported in this paper.

The most common subterranean isopod species of this region is *Asellus pricei*, described by Levi (1949) from Reftons Cave in Lancaster County, Pennsylvania. Two other subterranean forms, *Asellus conestogensis* Levi, 1949, and *Asellus condei* Chappuis, 1957, were also described from the same general area, but on the basis of a comparison of pertinent material these species are being synonymized with *A. pricei*. Because *A. pricei* is a significant subterranean species that has not been treated in detail since its original description by Levi, it is discussed at some length below.

Although there is a current trend among freshwater isopod specialists to divide the widespread Holarctic genus *Asellus* into subgenera and even separate genera (Matsumoto, 1962, 1963; Birstein, 1951; Henry and Magniez, 1968, 1970), we have not assigned the species treated in this paper to any of these more narrowly defined groups. Nevertheless, we are in agreement with the recent attempt of Henry and Magniez (1968, 1970) to subdivide the genus *Asellus* into natural groups that more clearly reflect phylogenetic lineages. These workers have recognized three separate genera of asellids from North America: *Asellus* Geoffroy, 1762 (restricted); *Conasellus* Stammer, 1932 (new status); and *Pseudobaicalasellus* Henry and Magniez, 1968, 1970 (new genus). The latter, as defined by Henry and Magniez (1968, 1970), should contain the eight species assigned to the *cannulus* group by Steeves (1969). All other described species of *Asellus* that occur east of the Rocky Mountains, including the new species described in this paper, should be assigned to *Conasellus*. The two species of *Asellus* which occur west of the Rocky Mountains should be retained in the genus *Asellus* (as restricted by Henry and Magniez). The newly erected genera, *Conasellus* and *Pseudobaicalasellus*, are endemic to North America, while *Asellus* s. str. is represented by species in Europe and Asia.

To us, this attempt to revise and subdivide the genus *Asellus* is one of the most logical to date. However, the problem with applying this new system to North American forms is the lack of comprehensive revision and critical comparison of North American asellids in general. Williams (1970), in a recent monograph on epigean asellids of North America, discussed some of the difficulties of dividing the genus *Asellus* into subgenera. Apparently Laurence Fleming, who is currently revising many of the North American hypogean species, has also decided against subdividing the genus at this time (L. Fleming, pers. comm. and in preparation). Temporarily, until many of the systematics problems currently plaguing students of the North American asellid complex have been resolved satisfactorily, we have elected to retain the genus *Asellus* s. lat. for the species treated in this paper.

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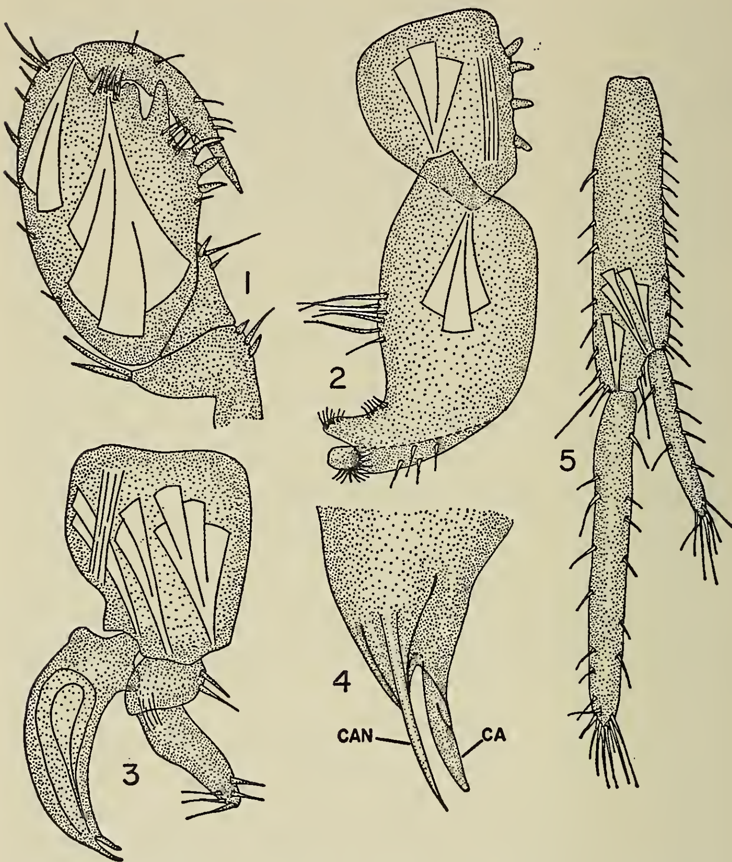
Asellus franzi new species

Figures 1–5

Asellus species B.—Steeves, 1969, pp. 55–56.

Material Examined: PENNSYLVANIA—Centre County: Millers Cave, holotype male, allotype, and 45 paratypes, J. R. Holsinger and J. A. Stellmack, 18 May 1965. MARYLAND—Garrett County: Crabtree Cave, R. Franz, 2 January 1967. The holotype and allotype are deposited in the United States National Museum of Natural History. Paratypes are in the collections of the authors.

Diagnosis: Albinistic, without eyes. Maximum body length 7.0 mm. Palm of propodus of male gnathopod (Fig. 1) with two processes: (1) median process large and acute, and (2) distal process small, bidentate and located near the opposable distal angle; opposable margin of dactyl without processes, but with small spines on entire length; carpus with 3 setae and 1 small spine near distal postaxial border. First pleopod (Fig. 2) with 4 coupling hooks; distal podomere approximately 1.6 times as long as proximal one; lateral margin with large setae on mid-region and smaller setae dispersed in scattered groups toward distal margin; terminal



FIGS. 1–5. *Asellus franzi* new species. 1, mesial view of distal podomeres of left gnathopod. 2, cephalic view of right first pleopod. 3, cephalic view of left second pleopod. 4, cephalic view of tip of endopodite of left second pleopod; CAN, cannula, CA, caudal process. 5, dorsal view of right uropod.

setae sparsely placed on distal margin; lateral margin bi-lobed distally. Second pleopod (Figs. 3, 4) without setae on mesial margin of basal segment; basal portion of endopodite without apophyses; tip of endopodite (Fig. 4) terminating in 2 distinct parts: (1) caudal process (CA) forming an elongate, sub-acute projection, and (2) endopodial groove extending in the form of an acute cannula (CAN). Uropod (Fig. 5) approximately 1.6 times as long as pleotelson; endopodite approximately

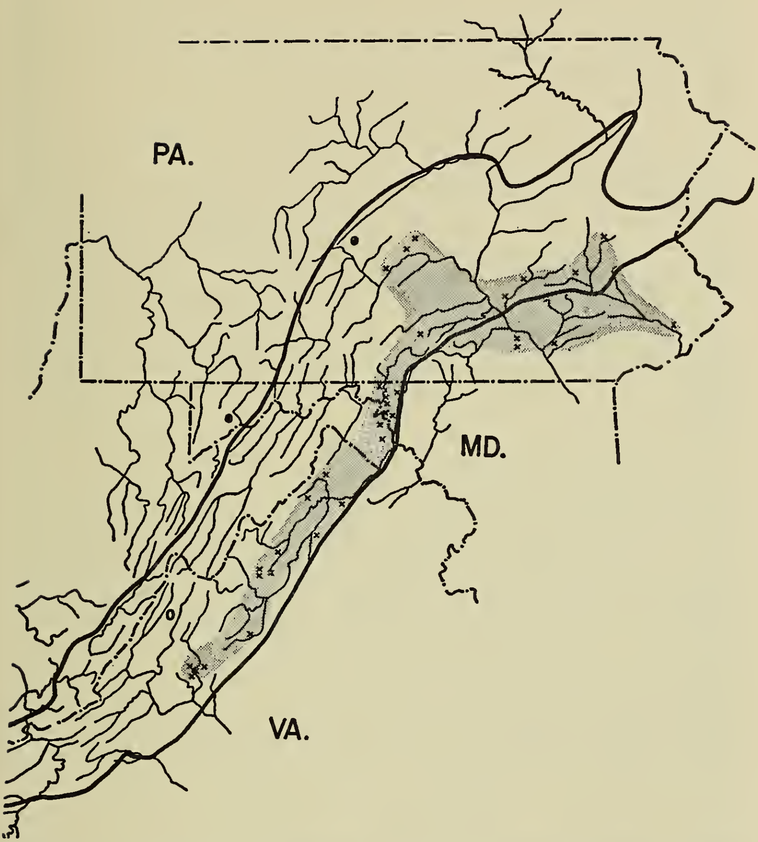


Fig. 6. Distribution of *Asellus pricei*, *A. franzi* new species, and new locality record for *A. holsingeri*. Solid circles are localities for *A. franzi*, open circle is new Virginia locality for *A. holsingeri*, and X's are localities (excluding Graham Spring) for *A. pricei*. Shaded area marks the presently known range of *A. pricei*. Heavy solid lines approximately delimit the Appalachian valley (= Valley and Ridge province).

1.1 times as long as peduncle; exopodite approximately 0.5 times as long as endopodite.

Distribution and Ecology: The two cave localities for this species (shown in Fig. 6) are separated by a linear distance of approximately 115 miles, a number of prominent valleys and ridges, and a major drainage divide (between the Potomac and Susquehanna river basins). Millers Cave (the type locality) is a small cave located less than 1 mile east of

Rockspring, Pennsylvania, and is developed in Ordovician limestone which crops out just west of Tussey Mountain. Crabtree Cave is a relatively large cave located in the Appalachian Plateau of western Maryland and is excavated in Mississippian limestone of the Greenbrier series (Davies, 1950). In both caves, *A. franzi* was collected from under gravels in small streams where it was associated with subterranean amphipods of the genus *Stygonectes*.

Relationships: Morphologically, *A. franzi* is related to species of the *stygius* group of *Asellus* (Steeves, 1963a, 1965, 1966) and is being tentatively assigned to this group. In the male, this relationship is indicated by similarities in the armature of the palmar margin of the gnathopod and the structure of the endopodial tip of the second pleopod. However, *A. franzi* can be distinguished from most other species of the *stygius* group by the absence of the mesial process on endopodial tip of the male second pleopod and from all other species of this group by the presence of the distinct, bi-lobed outer margin of the distal segment of the male first pleopod.

It is perhaps zoogeographically significant that all other species of the *stygius* group occupy contiguous or overlapping ranges in the southern Appalachians, Interior Low plateaus, and Ozark Plateau (Steeves, 1966, fig. 8), while *A. franzi* is disjunctly distributed much farther east and northeast in a small part of the upper-central Appalachians. Moreover, a part of the area between the range of *A. franzi* and the ranges of other species of the *stygius* group is occupied by species of the *cannulus* group of *Asellus* (Steeves, 1965, 1966, 1969) which occur in caves in eastern West Virginia and west-central Virginia.

Etymology: It is a pleasure to name this new species in honor of Mr. Richard Franz, a director of the Maryland Cave Survey, who has been very active in the biological exploration of Maryland caves.

Asellus holsingeri Steeves

Asellus holsingeri Steeves, 1963b, pp. 462–464, figs. 1–5 [Type locality: Organ-Hedricks Caves (= Greenbrier Caverns), Greenbrier County, West Virginia].—Steeves, 1965, p. 84.—Steeves and Holsinger, 1968, p. 81.—Steeves, 1969, p. 56.

Material Examined: Virginia—Bath County: Butler Cave, 19 females and 16 males, J. Holsinger, T. Vigour and L. Vinzant, 2 November 1968.

Distribution and Ecology: This species was collected from under gravels and flat rocks in a stream in Butler Cave (Butler-Sinking Creek Cave System), where it is commonly associated with snails (*Fontigens orolibas* Hubricht) and rarely with amphipods (*Stygonectes conradi* Holsinger).

Extensive field work in central Appalachian caves has considerably extended the range of *A. holsingeri* since its description by Steeves (1963b). In a more recent paper on cave isopods, Steeves (1969) gave the range of this species as extending from the extreme western part of

Maryland southward through eastern West Virginia to Monroe County. The material from Butler Cave marks the first Virginia record for this species and extends its range 25 miles to the east (see Fig. 6).

Asellus pricei (Levi)

Asellus new species.—Dearolf, 1941, pp. 170–171.

Caecidotea pricei Levi, 1949, pp. 1–6, figs. 1–3, 7–10 [Type locality: Refton Cave, Lancaster County, Pennsylvania].—Nicholas, 1960a, p. 131.—Nicholas, 1960b, pp. 51–52.

Asellus pricei (Levi).—Dearolf, 1953, p. 227.—Mackin, 1959, p. 876.—Holsinger, 1963, p. 29.—Steeves, 1963b, p. 462.—Holsinger, 1964, p. 60.—Steeves, 1969, pp. 53, 55.

Caecidotea conestogensis Levi, 1949, p. 3, figs. 4–6, 11–13 [Type locality: Hammer Creek, about 2 miles from Buffalo Springs, Lebanon County, Pennsylvania.]. NEW SYNONYMY.—Nicholas, 1960a, p. 131.—Nicholas, 1960b, pp. 51–52.

Asellus conestogensis (Levi).—Steeves, 1963b, p. 463.—Steeves, 1969, p. 53.

Asellus condei Chappuis, 1957, pp. 37–43, figs 1–8 [Type locality: Ogdens Cave, Frederick County, Virginia]. NEW SYNONYMY.

Asellus richardsonae (Hay).—Dearolf, 1937, p. 45 (in part).

Caecidotea stygia Packard.—Richardson, 1905, p. 434 (in part).—Nicholas, 1960a, p. 132 (in part).—Nicholas, 1960b, p. 51–52 (in part).

Recorded Localities: MARYLAND—Washington County: Dam Number Four, Fairview, Jugtown, Natural Well, Rohrersville, and Spring caves. PENNSYLVANIA—Berks County: Hobo and Schofer caves; Cumberland county: Carnegie Cave; Dauphin County: Brownstone Cave; Lancaster County: Refton Cave (Type locality); Lebanon County: Hammer Creek near Buffalo Springs; Mifflin County: Aitkin, Goss and Johnson (upper and lower) caves; Montgomery County: well (200 feet deep) in Conshohocken; York County: Bootlegger Sink and North York caves. VIRGINIA—Augusta County: Barterbrook Springs Cave; Frederick County: Ogdens Cave; Page County: Will Mauck Cave; Rockbridge County: Bathers, Billy Williams (now closed by highway construction), Showalters, and Tolleys caves and Grahams Spring; Rockingham County: Endless Caverns, Florys Spring, and seeps in front of Massanutten Caverns and on south side of Harrisonburg; Shenandoah County: Flemmings Cave; Warren County: Skyline Caverns. WEST VIRGINIA—Jefferson County: Ditmers and Molers caves.

Most of the localities listed above are based on material examined by the writers; a few were taken from the literature but fall within the established limits of the range. Grahams Spring was listed by Richardson (1905, p. 434) as a locality for *Caecidotea stygia* (*A. pricei*, in part) but could not be positively identified during recent field work. However, it is probably one of several limestone springs located near the town of Lexington, Virginia.

Variation: Despite the wide range of this species, little morphological variation was discernible in different population samples. For example, the morphology of the endopodite of the second pleopod of the male, a structure of singular diagnostic value among species of *Asellus*, remained relatively constant throughout the range. There was, however, a slight degree of variation in the armature of the palmar margin region of the propods of the male gnathopods, ranging from reduced or incompletely developed processes in some to well developed in others. However, this variation did not show a geographic pattern and was not different from the palmar margin variation found in some other species of the genus.

Distribution and Ecology: The range of this species (see Fig. 6) extends from Montgomery County, Pennsylvania, west across the Piedmont into the Valley and Ridge province of central Pennsylvania, and then southwestward through the "Great Valley" of central Maryland, northeastern West Virginia, and western Virginia to Rockbridge County in west-central Virginia. *Asellus pricei* occurs in parts of four major drainage basins, including the Delaware, Susquehanna, Potomac, and James (Steeves, 1969).

Asellus pricei is usually found under rocks, gravels, and small pieces of wood in cave streams and pools, although occasionally it is found in small springs and groundwater seeps during the spring of the year. Specimens were found to be very abundant in a number of caves visited by the senior author; especially in Reftons Cave (type locality), where a population numbering in the thousands was observed clinging and crawling on pieces of submerged wood in a large pool. Another large population was observed in submerged leaf litter just beyond the resurgence of a temporary spring (seep) in front of Massanutten Caverns in the spring of 1965.

Although primarily known from cave waters, *A. pricei* is by no means a strict cavernicole. Apparently this species can occupy almost any groundwater biotope within its range. In Rockingham County, Virginia, *A. pricei* was collected from two spring-seeps developed in Ordovician-aged Martinsburg shale. These collections were made in April after heavy rainfall had effected a temporary rise in the groundwater table. This species was also collected from a deep well located in lower Cambrian-aged metamorphic rock in southeastern Pennsylvania.

Most of the recorded cave localities for *A. pricei* occur in Paleozoic limestones (Cambrian and Ordovician), but the free movement of this species from one cave to another over any extended distance under the geological conditions imposed by the nature of the limestones of the Great Valley region of the Appalachians is improbable. Most of the caves in this part of the Appalachians are small and isolated, and the amount of cave interconnectivity is greatly restricted by relatively narrow strike bands, intense folding, and extensive faulting.

The potential ability of small troglobitic (or phreatobitic) crustaceans such as amphipods and isopods to move through superficial groundwater habitats developed close to the surface and often in noncavernous strata or in overlying mantle has been discussed previously in detail by Holsinger (1967, 1969), Steeves and Holsinger (1968), and Steeves (1969). This theoretical mode of dispersal has been termed "interstitial dispersal" and its application to explain the wide range and vagility of *A. pricei* seems feasible in view of the evidence at hand.

Relationships: To date it has been impossible to assign *A. pricei* to any of the species groups established within the genus *Asellus* by Steeves (Steeves, 1969). The morphological combination seen in the structure of the gnathopods and pleopods in the male is apparently unique in North American cave asellids and probably represents a separately evolved lineage. Only one other North American species appears closely related morphologically, this being *A. kenki*, a subepigean species described by Bowman (1967) from springs in the Virginia-Maryland area surrounding Washington, D.C., and from two caves in southwestern Pennsylvania. Although pigmented and eyed, *A. kenki* is, as pointed out by Bowman (1967), in some respects intermediate between the epigean and troglobitic species of *Asellus*. In contrast to *A. pricei*, *A. kenki* is predominately an inhibitant of permanent springs. *A. pricei*, on the other hand, is an unpigmented, eyeless form primarily restricted to subterranean groundwater habitats. Theoretically, these two species may have overlapping ranges, but they have never been taken from the same immediate area. A large disjunction in the bicentric range of *A. kenki* occurs between the southwestern Pennsylvania localities on the west and the Virginia-Maryland localities on the east. Although this disjunction is possibly the result of inadequate collecting it is nevertheless partially filled by the range of *A. pricei*. The fact that *A. pricei*, and not *A. kenki*, has been taken from this area suggests a scarcity or absence of the latter rather than inadequate collecting. It also may be significant that *A. kenki* inhabits springs in the eastern part of its range and caves in the western part, whereas *A. pricei* inhabits caves in between.

In view of the proximity of ranges, similarity in structure, and overlapping ecologies, one might be persuaded to speculate on the possible evolutionary relationship between these two species. There are at least two possible relationships indicated by the available data. One, that *A. kenki* is closely related to, or represents the remnant surface form of, an ancestral stock that invaded subterranean waters and subsequently evolved into *A. pricei*. Two, that both species were derived from a common epigean ancestor in the not too distant past. Undoubtedly, both of these explanations are oversimplified, and before either are pursued any further, a critical comparison of the morphology and ecology of these two species should be made.

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